THE RELATIONSHIP OF SPECIFIC READING SKILLS TO HIGH AND LOW ACHIEVEMENT IN ARITHMETIC PROBLEM SOLVING

A THESIS

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BY

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DEDICATION

This thesis is dedicated to my daughters,

Lolita and Barbaralane

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The writer wishes to express her thanks to Dr. Denton, advisor, for his advice and criticisms. The writer would also like to extend gratitude to Mrs. Miriam Jellins and Mrs. Louise Boswell for inspiring me, which made the conducting of this study possible.

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Rationale

Reading is generally considered the most essential subject that is taught in the elementary schools of today. It has an important place in nearly every phase of school work. The effective use of reading skills is the tool through which the child obtains a large portion of the subject matter of the content fields. Unless the child acquires a certain facility in reading, his educational progress is seriously hampered. Although each content area has its own terminology and method of approach, it is important that the learner be able to transfer the skills learned in reading to the tasks which must be mastered in each content area.[1]

In the modern curriculum a pupil reads more widely than ever before where his interest in specialized content subjects compel him to develop reading competence for more specialized types of reading.

Regardless of whether the child reads content subject matter through his own search or in connection with a particular assignment, the specialized subject matter itself fundamentally remains the same.[2] Consequently, the teacher should devote attention to four essential teaching tasks. These are: (1) the development of vocabulary peculiar to the subject, (2) the development of concept background needed for

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[1] Albert J. Harris, How to Increase Reading Ability (New York: David MacKay Company, 1961), p. 3.

[2] Nila Banton Smith, Reading Instruction for Today's Children (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1963), pp. 305-06.

understanding what is being taught, (3) knowledge of how to read the texts and other materials efficiently and effectively, (4) interpretation of the symbols.

The modern arithmetic curriculum is an outgrowth of various influences which have been operative over a period of years. Some factors have been in the picture for more than thirty years, others are of more recent origin - or are being recognized more recently as having significance. Among the more prominent of these influences are the changing philosophy of education, increased knowledge of child development, clarification of the nature of human learning, a rethinking of the purposes of instruction in arithmetic and changes in our culture. As a result of these influences arithmetic curriculums are being much more realistic about what children need in arithmetic and what seems appropriate and within children's capabilities at various age levels. Considerable research evidence has been accumulated on the nature of the learning process in arithmetic, the nature and the place of meanings in arithmetic, and upon the comparative value of various methods of instruction. Every advantage should be taken of the findings thus far in planning sound progress in arithmetic for children of elementary school age.[1]

Intelligence is a recognized factor in reading achievement and arithmetic achievement. The correlation between reading achievement and intelligence tends to be high but fluctuates with specific tests used.

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[1]Charlotte Junge, "The Arithmetic Curriculum," The Arithmetic Teacher, I (April 1964), p. 154.

Spache[1] emphasizes that reading performances are influenced by such factors as age, sex, mental ability, social class, cultural and linguistic background, interest and motivation of the learner. Social acceptance by peers, physical development, educational, work experiences and the attitudes of parents toward education also effect school performances. He suggests wherever possible the influence of these elements must be considered in attempting a realistic evaluation of the students' reading progress.

Teachers know that children learn best when they understand the meaning of what they are reading, in terms of their own experiences and interests. There are two kinds of meanings in arithmetic. One is the intrinsic meaning of the quantitative relationships which underline mathematical thinking. The other is the functional meaning connected with children's experiences. Both kinds of understanding are essential in arithmetic teaching. The intrinsic involves the abstract meanings of elementary mathematics, and the functional applies arithmetic to practical, concrete situations.

Today, with interest centered on the development of mathematical concepts, from a mathematical point of view, word problems which emphasize aspects of application often receive scant attention. Considered to be of relatively little importance, they are used merely to provide additional motivation or a familiar setting for the better understanding of better operations.[2]

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[1]George D. Spache, Toward Better Reading (Champaign, Illinois: Garrard Publishing Company, 1963), p. 355.

[2]Adaline P. Hagaman, "Word Problems in Elementary Mathematics," The Arithmetic Teacher, XI (January, 1964), p. 250.

A fundamental objective of the modern elementary school is the development of the total individual. The realization of this objective necessitates a kind of learning situation which will foster total growth of the child mentally, physically, socially, emotionally and morally. These areas are usually considered to be the broader or long range objectives to arithmetic. Brueckner and Grossnickle[1] say:

> . . . the teacher should . . . recognize the possible contributions instruction in arithmetic can make to the social objectives of all education. Many of the experiences pupils have in school that are rich in application of number can be designed as experiences in democratic living. Here the teacher can so conduct the learning program that intelligence . . . forms the basis of action. Actual practice in solving problems of daily life that are of concern to the pupils is a most valuable type of experience in democratic living. In most instances arithmetic makes valuable contributions to these experiences.

The need for consideration of the whole child is stated by Caswell and Forshay:[2]

> A teacher cannot teach arithmetic alone, or spelling, or reading. Subject matter cannot be considered apart from children and in every experience the whole child is affected. A teacher may ignore attitudes, effects on character, and the like, when teaching children arithmetic, but the effects are there nevertheless.

Reading may be considered some what essential to the development of quantitative reasoning skills, or as has been discussed, to some aspects of the application of reading skills to arithmetic problem solving. The question arises as to whether there are specific reading

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[1] Leo J. Bruckner and Foster E. Grossnickle, Making Arithmetic Meaningful (Philadelphia: The J. C. Winston Company, 1953), p. 570.

[2] Hollis L. Caswell and Wellesley A. Forshay, Education In The Elementary School, second edition (New York: American Book Company, 1950), p. 406.

skills which must be possessed by all who would succeed in solving arithmetic problems. Research has established the relationship between achievement in the two areas, but this inquiry is concerned primarily with specific measurable reading skills and their relationship to quantitative reasoning.

Evolution of the Problem

The problem evolved from the writer's observation of a large number of children who, according to teachers' evaluation, had made average and above average grades in their arithmetic and reading classes but where there was not an appreciable degree of similarity between class performance and scores made by these children on standardized achievement tests. This discrepancy in the teachers evaluation and the performance on standardized achievement tests indicated that the children were experiencing some difficulty in the area of problem solving and reading. It was at this point the writer decided to pursue this study through research.

Contribution to Educational Research

The writer believes that the findings in this study will be of value to elementary teachers, in planning for the integration of the reading and instructional programs. The more that is known about the specific reading skills necessary to achievement in arithmetich reasoning, the better the experiences which can be provided for instruction in these areas.

Statement of the Problem

The problem with which this study concerns itself is that of identifying specific reading skills which are related to high and low achievement in arithmetic problem solving.

Purposes of the Study

It was the general purpose of this study to ascertain whether or not pupils can be differentiated in terms of ability to reason quantitatively by competence or non-competence in performance of a selected group of reading skills. The study therefore, tests the following null hypotheses:

1. Subjects who are high achievers in solving arithmetic reasoning problems are not significantly more competent in word attack skills than are subjects who are low achievers in the solving of arithmetic reasoning problems.

2. Subjects who are high achievers in solving arithmetic reasoning problems do not score significantly better on selected vocabulary tests than do subjects who are low achievers in the solving of arithmetic reasoning problems.

3. Subjects who are high achievers in solving arithmetic reasoning problems do not test significantly higher on the reading comprehension component of an achievement battery than do subjects who are low achievers in the solving of arithmetic reasoning problems.

Specifically the purposes of the study are:

1. To determine the differences in performances of high and low achievers in arithemtic reasoning on each component of the McCullough Word Analysis Test.

2. To determine the differences in performances of high and low achievers in arithmetic reasoning on the vocabulary component of the Metropolitan Achievement Test.

3. To determine the differences in performances of high and low achievers in arithmetic reasoning on the reading comprehension component of the Metropolitan Achievement Test.

4. To draw from the findings warranted conclusions, implications and recommendations which may lead to better instructional practices.

Definitions of Terms

For this study the following terms are defined:

1. Arithmetic reasoning refers to the ability to solve verbal problems, and a measure of important understandings and concepts such as aspects of the number system, mathematical generalizations, approximate answers as measured by the Metropolitan Achievement Tests.[1]

2. Reading vocabulary refers to a knowledge of literal meaning as measured by the Metropolitan Achievement Tests.[2]

3. Reading comprehension refers to abilities to recognize directly stated facts, to make inferences, to follow directions, to discriminate between true and false conclusions, and to perceive relationships as measured by the Metropolitan Achievement Tests.[3]

4. Word attack skills refers to pupils' abilities to master and apply certain phonetic and structural-analysis skills as measured by the McCullough Word Analysis Tests.

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[1] W. N. Durost, Metropolitan Achievement Tests (Elementary Battery) Form A (New York: Harcourt, Brace and World, Inc., 1959.

[2] Ibid.

[3] Ibid.

[4] Constance M. McCullough, McCullough Word-Analysis Tests (Atlanta: Ginn and Company, 1963).

Research Procedure

The Descriptive Survey Method of research was used in conducting this investigation. This method of research is practical in gathering the data for this problem. It identifies conditions and points to present needs.

The subjects for this study were randomly selected from the fourth grade pupils whose I. Q.'s range from 80 - 110 and whose chronological ages range from nine years to ten years, eleven months. Once a random selection had been made of fifty children meeting the above criteria, selections were made on the basis of performances in arithmetic reasoning components of the Metropolitan Achievement Test as recorded in permanent record folders. Pupils whose score comprise the highest third for the entire group were identified as high arithmetic achievers, while pupils whose scores comprise the lowest third for the entire groups were identified as low arithmetic achievers. High and low achieving groups comprised the samples for the study.

Pitts Elementary School from which the subjects of this study were selected is located six miles from downtown Atlanta, in a low socio-economic area that is comprised of many apartments, a thirteen hundred low rent housing project, a low cost sub-division, few playgrounds, one community center, three churches and no public parks.

The community is bound on the north, south, east and west with similar communities and a large railroad system - Inman Yards. There are five schools, four are elementary and one is a high school within a one mile radius.

Pitts, one of the five schools, is a large modern structure equipped with sixty rooms, one auditorium, three offices, one planning room, two libraries, one cafeteria, and two kindergarten rooms. The school offers work in grades K through 7. All teachers hold bachelor degrees with 20 per cent holding Master's degrees and above. The Special Service Program, financed through Title I, includes one Social Worker, one Lead Reading Teacher, a Special Seventh Grade Team and Teacher Corp. participation. The enrollment at present is 1,303 with 120 in the kindergarten.

This study was conducted during the spring and summer of 1968.

Description of Instruments.--The instruments used in this study were:

> The California Short Form Test of Mental Maturity, Elementary, consists of seven tests. These tests sample various kinds of mental processes to establish the level and rate of mental development. The seven tests contribute scores in four factors: (a) spatial relationship, (b) logical reasoning factors, (c) numerical reasoning, and (d) verbal concepts.[1]
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> The Metropolitan Achievement Tests, Elementary Battery, Form A was administered to the pupils. The test comprised a coordinated series of measures of achievement in the important skill and content areas of the elementary curriculum. The test provided for the analysis of pupils' achievement and consisted of seven tests. The three with which the writer was concerned were: Test I, Word Knowledge was a 50-item vocabulary test, Test II, Reading, designed to measure various aspects of reading comprehension. Test VII, Arithmetic Problem Solving and Concepts, comprised two parts - a measure of ability to solve verbal problems, and a measure of important under-

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[1] Elizabeth T. Sullivan, et al., California Short-Form Test of Mental Maturity, Elementary (Los Angeles: California Test Bureau, 1957).

standings and concepts such as aspects of the number system, mathematical generalizations, and approximate answers.[1]

The McCullough Word Analysis Tests were used in this study to measure the extent to which pupils have mastered and can apply certain phonetic and structural-analysis skills that are important in the reading process. There were seven tests, each containing 30 items. The four with which the writer was concerned were: Test I, Initial Blends and Diagraphs tested the pupil's ability to hear consonant blends or diagraphs and to identify the letters which made the sound. Test II, Phonetic Discrimination, tested the ability to hear vowel sounds. Test III, Matching Letter to Vowel Sounds, tested the ability to hear the vowel sounds and identify the letters which made them. Test VI, Dividing Words into Syllables, tested the ability to apply eight rules of syllabication in the division of words.[2]

The procedural steps used in the collection, analysis, interpretation of the data were:

1. The thesis outline was prepared and presented at a spring 1968 seminar.

2. The literature pertinent to this study was gathered, reviewed and presented in the final thesis copy.

3. The subjects for this study were randomly selected from the fourth grade pupils whose I. Q.'s range from 80-110 and whose chronological ages range from nine years to ten years, eleven months. Once a random selection had been made of fifty children meeting the above criteria, selections were made on the basis of performances in arithmetic reasoning components of the Metropolitan Achievement Test as recorded in permanent record folders.

4. Data necessary for this study was collected by analyzing and interpreting the results of the McCullough Word-Analysis Tests which were administered to these subjects.

5. Information concerning vocabulary was collected from the results of the vocabulary component of the

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[1] Ibid.

[2] McCullough, op. cit.

Metropolitan Achievement Test included in the permanent record folders concerning these subjects.

6. Information concerning levels of comprehension were gathered from the results of the reading comprehension component of the Metropolitan Achievement Test included in the permanent record folders concerning these subjects.

7. The statistical measures applied to the study were: (a) the mean which measures the sum of a set of scores divided by the number of scores, (b) the standard deviation which measures the variability of a set of scores, (c) Fisher's t test to test for the significance of differences in mean scores.

Survey of Related Literature

Literature related to this study was presented in the following categories: (1) studies related to arithmetic underachievers; (2) the relationship between reading and arithmetic; (3) the relationship of quantitative reasoning to reading.

Researchers have tended to investigate curricular sequence and scope in the area of arithmetic, particularly stressing an analysis of the difficulty of the various arithmetical processes. These studies have been of great value in the development of textbooks and programs of instruction enabling many students to make satisfactory progress in arithmetic. However, the findings have provided little direct information about children who experience unusual difficulty in mastering arithmetic in spite of adequate general learning aptitude.[1]

In this study, case studies were obtained of twenty sixth and seventh grade students of average or above average intelligence who

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[1]Ramon Ross, "A Description of Twenty Arithmetic Underachievers," The Arithmetic Teacher, XI (April, 1964), pp. 235-241.

were two years or more below their mental grade level in arithmetic achievement as measured by standardized tests.

The subjects of this study were a total of 353 fifth, sixth and seventh graders and were identified in the initial screening as possessing I. Q.'s of 100 or more on the California Test of Mental Maturity and were one year or more below grade level on the arithmetic section of the Stanford Achievement Test.

The arithmetic sub-test of the Jastak Wide Range Achievement Test, was administered as the next step in screening. From this group of 353 students, twenty sixth grade students and twenty seventh grade students were identified who had CTMM scores of 100 or more and Jastak arithmetic sub-test scores two years below their mental age. No fifth graders were identified who met these criteria.

Twenty students who were among those with the greatest disparity between obtained Jastak scores and expected Jastak scores were selected for case studies. Twelve were sixth graders and eight were seventh graders. Two of the sixth graders and three of the seventh graders were girls. The remainder were boys.

The findings of this study are arranged by areas of investigation and include information relating to arithmetic performance, general academic performance including reading, intellectual abilities, physical characteristics, personal-social behavior, and home and family background.

1. Subjects evidenced satisfactory reasoning with word problems involving addition and subtration of whole numbers, but made frequent reasoning errors in problems involving multiplication and division of whole

numbers as well as in all the processes involving common fractions.

2. Sixteen of the subjects were one or more years below their mental grade level in functional reading ability as measured by the Durrell Analysis of Reading Difficulty.

3. Sixty-three per cent of the causes of underachievement identified by classroom teachers were of an emotional nature, involving lack of interest, home or school maladjustment, short attention span or limited initiative.

4. Fifteen of the subjects had shown immaturity or slowness of general development, while thirteen of them manifested abnormal physical conditions, ranging from low vitality to rheumatic fever.

5. Parents tended to be from lower socio-economic classes. Three parents owned small businesses, two were salesmen, twelve were skilled or unskilled laborers, and three were unemployed.

6. Parents of twelve of the subjects tended to hold one or more teachers responsible for their child's inadequacies.

7. Teacher assessment and cumulative records indicated that subjects were underachieving generally in school subjects other than arithmetic.

8. Teacher assessment and personality tests indicated that subjects characteristically were withdrawn and defeated in their attitudes toward school and society.

The Relationship Between Reading and Arithmetic

Coffing conducted a study in 1941 using 355 pupils in grades 4^B through 8^A to determine the relationship between silent reading ability and arithmetic ability. She found that there is a positive relationship between scores made in paragraph meaning and arithmetic reasoning. As a general trend the pupils who make high scores in read-

ing are the ones who make high scores in arithmetic. Coffing points out that teachers should try to improve the child's reading ability in arithmetic reasoning.[1]

In 1944, Treacy studied 244 pupils in the 7^B to see if general reading level was related to ability to solve problems in arithmetic. He found that good readers were the best problem solvers.[2]

The relationship of certain reading abilities to success in mathematics was studied by Eagle in 1948. He concluded that the content of mathematics courses should be selected and organized to place more emphasis on mathematics as a method of organizing and presenting data, to the relationship of various methods to one another, and to the process of problem solving.[3]

Many investigations have been made to learn why pupils fail in problem-solving in arithmetic. Various factors associated with pupil failure have been identified. Among them are the following: (1) physical and mental defects, (2) inability to read or careless reading, (3) lack of interest, (4) lack of computational ability, (5) lack of knowledge of fundamental and essential facts, (6) lack of method of

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[1]Esther A. Coffing, "The Relationship Between Silent Reading Ability and Arithmetic Ability," School Science and Mathematics, XLI (January, 1949), pp. 10-14.

[2]John P. Treacy, "The Relationship of Reading Skills to the Ability to Solve Arithmetic Problems," Journal of Educational Research, XXXV (October, 1944), pp. 174-179.

[3]Edwin Eagle, "The Relationship of Certain Reading Abilities to Success in Mathematics," The Mathematics Teachers, XLI (April, 1948) pp. 175-179.

attacking problems, (7) inadequate knowledge of vocabulary, and (8) poor teaching.

Among the more significant reasons why pupils have difficulty in solving problems are inability to comprehend the statement of the problem and lack of vocabulary. In nearly every investigation of the causes of pupils' difficulties in solving arithmetic story problems these factors have been closely related to low achievement.

Although a number of language factors, including knowledge of vocabulary, have been identified as major sources of difficulty in the solution of verbal problems, the precise nature of the relationship between language factors and successful problem-solving is not sufficiently understood. Some authorities believe that there is a positive relationship between specific reading abilities and problem-solving ability. Yet the specific reading skills identified are not consistent from study to study. There is no evidence to date that relates success in problem-solving to a single language factor.

Comparisons of high and low achievers in problem-solving led Hansen[1] and Treacy[2] to conclude that knowledge of vocabulary is essential to the successful solutions of problems and that the study of mathematical vocabulary should be an important objective of instruction.

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[1]Carl Hansen, "Factors Associated with Successful Achievement in Problem Solving in Sixth Grade Arithmetic," Journal of Educational Research, XXXVIII (October, 1944), p. 115.

[2]John P. Treacy, "The Relationship of Reading Skills to the Ability to Solve Arithmetic Problems," Journal of Educational Research, XXXVIII (October, 1944), p. 94.

Many of the summaries of research relative to problem-solving in arithmetic indicate a need for studies dealing with the role of reading ability. In The Encyclopedia of Educational Research, Wilson states, "The Question of the nature of the reading instructions that should be given has received only limited attention, and further research is needed, before any conclusions can be stated."[1]

Corle says, "Understanding the terms used in arithmetic is a definite factor in problem-solving efficiency. Teachers must insure familiarity with the vocabulary of verbal problems if effective problem-solving is to result."[2]

In a discussion of the nature of problem-solving in arithmetic, Johnson pointed out that vocabulary is one of the main factors in a student's ability to solve problems.[3] As an example, a student can hardly be expected to solve a problem dealing with the volume of a rectangular solid unless he knows the meanings of volume and rectangular solid, and unless he knows a process of solving the problem.

Despite the fact that many types of studies dealing with problem-solving have been conducted, there is still need for studies in this area. For example, studies are needed which relate to the way children learn arithmetic concepts, the thought processes involved in

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[1]Guy Wilson, "Arithmetic," Encyclopedia of Educational Research (New York: The Macmillan Company, 1950), p. 54.

[2]Clyde G. Corle, "Thought Processes in Grade Six Problems," The Arithmetic Teacher, V (October, 1958), pp. 193-203.

[3]J. T. Johnson, "On The Nature of Problem Solving in Arithmetic," Journal of Educational Research, XLIII (October, 1949), pp. 110-115.

solving problems, and the manner in which children make choices regarding the processes used. Stevenson has stated that more detailed research should be undertaken to show how much time and effort should be expended in giving pupils a method of attacking problems, in training them to estimate answers, and in assisting them to understand technical words and other phases of instruction.[1]

The Relationship of Quantitative To Reasoning Reading

Since 1918, when Monroe showed that a given problem could be verbally stated in twenty-eight different ways, research workers have been interested in relationship between reading achievement and arithmetic achievement.[2] The resulting research has not been clear on what relationship exists, often because of the confounding effects of intelligence.

Intelligence as defined by Merry and Merry, refers to the individual's capacity to acquire learning from experiences. Generalizations employ a higher degree of mental gymnastics than do the understandings of concepts alone.[3]

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[1]P. R. Stevenson, "Increasing the Ability to Solve Arithmetic Problems," Educational Research Bulletin, III (October, 1924), pp. 267-270.

[2]Walter S. Monroe, "The Derivation of Reasoning Tests in Arithmetic," School and Society, VIII (September, 1918), pp. 295-99, 324-29.

[3]Merry and R. Merry, The First Two Decades of Life (New York: Harper & Brothers Publishers, 1958), p. 345.

Intelligence is a recognized factor in arithmetic achievement and in reading achievement. The correlation between reading achievement and intelligence tends to be high but fluctuates with the specific tests used. Monroe, using mental age derived from the Revised Stanford Binet Intelligence Test, found correlations from .56 to .65 with reading ability.[1]

Strang using the language score on the California Tests of Mental Maturity, found correlations between .80 and .84 with reading achievement.[2]

Brueckner and Grossnickle, have specified the intercorrelations between intelligence and various arithmetic skills, with a low of .35 between I. Q. and computation and a high of .766 between I. Q. and vocabulary.[3]

Fay, controlled chronological and mental age in comparing his groups. Working with good and poor readers, he found no differences in arithmetic achievement between the groups with intelligence held constant.[4]

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[1]Marion Monroe, Children Who Cannot Read (Chicago: University of Chicago Press, 1932).

[2]Ruth Strang, "Relationships Between Certain Aspects of Intelligence and Certain Aspects of Reading," Educational and Psychological Measurement, III (May, 1943), pp. 355-59.

[3]Leo J. Brueckner and Foster E. Grossnickle, Making Arithmetic Meaningful (Philadelphia: The John C. Winston Co., 1953), pp. 434-35.

[4]Leo C. Fay, "The Relationship Between Specific Reading Skills and Selected Areas of Sixth-Grade Achievement," Journal of Educational Research, XLIII (March, 1950), pp. 544-47.

Reading achievement would not be related to computation skill with the effects of intelligence controlled. Little reading skill is involved in finding solutions for examples. The subject need only read numbers and operations signs. The minimum reading knowledge required in computation would result in a very low correlation between reading and computation (if the effects of intelligence were controlled).

It is in the area of problem solving or arithmetic reasoning that reading would seem to be important. Problems are specified by words. In problem-solving, the subject matter must determine the question being asked, the information given, the arithmetical operations required and must find this information through reading. Obviously, reading ability is involved. However, general reading ability has not been found to correlate highly with problem solving ability as measured by standardized tests.[1]

Hansen, studying problem solving in arithmetic, found no significant differences between good and poor students in comprehension abilities, but he did find that the poor achievers in arithmetic were, on the average, faster readers.[2]

Comparisons of the reading skills of "good" and "poor" achievers in arithmetic leaves much to be desired. If reading skill is important in problem-solving ability, a continuum may well exist,

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[1] David H. Russell, "Arithmetic Power Through Reading," Instruction in Arithmetic, Twenty-fifth Yearbook, Chapter 9 (Washington: National Council of Teachers of Mathematics, 1960), pp. 211-12.

[2] C. W. Hansen, "Factors Associated With Superior and Inferior Achievement in Problem Solving in Sixth-Grade Achievement" (unpublished Ph.D. dissertation, University of Minnesota, 1943).

with each increase in reading ability being accompanied by an increase in problem-solving achievement. It is also possible that a minimum level of reading ability is required to do well in problem-solving at any grade level.

The relationship of computation skill to problem-solving or arithmetic reasoning would appear to be more direct. Problem-solving requires computation skill -- the child who is unable to compute is unable to solve problems requiring computation. However, tests of problem-solving ability rely upon computation skills taught at the grade level for which the test is designed. That is, a sixth-grade test of problem-solving have few, or no, requirements for computation skills not taught prior to grade seven.

This study was designed to determine if level of general reading ability is significantly associated with problem-solving ability, if level of computation skill is significantly associated with problem-solving ability, and if a high level of ability in one of these areas will compensate for a low level of ability in the other. All levels of reading ability were secured, as well as all levels of computation skill, in determining the effect on these factors on problem-solving.

All sixth-grade students in a Southern California community were involved in this study. A total of 1400 children completed the testing. The Stanford Achievement Tests, Intermediate, Form KM: Reading and Arithmetic, were administered in February. The average grade placement in reading of the scores on the word meaning and paragraph meaning sub-tests was used as the criterion measure of reading ability. grade placement on the computation sub-test as the criterion measure

on computation skill, and grade placement on the reasoning sub-test as the measure of problem-solving ability. The California Short-Form Test of Mental Maturity, Elementary, 1957, was administered and the total I. Q. used as the measure of intelligence.

The children were then classified according to level of computation ability and level of reading ability. From the resulting classification, 468 children (23 from each cell) were randomly selected and their arithmetic reasoning scores compared, using the analysis of convariance and controlling I. Q. to determine the importance of reading ability, computation ability, and interaction of problem-solving.

The findings of Hansen's investigation are as follows:

1. General reading ability does not have an effect on problem-solving ability. The findings of this study may differ from previous studies because the total range of reading ability was used rather than two groups defined as good and poor readers. Also, the effect of intelligence was controlled.

   It is suggested that the vocabulary and reading difficulty control of standardized tests (which differs from grade level texts) may actually minimize the effect of reading, and that if a more normal reading skill might prove to be more important.

2. When I. Q. is not controlled, much of the apparent relationship between reading and problem-solving ability is the result of the high correlation of each of these factors with I. Q. Controlling I. Q. drastically reduces the degree of relationship.

3. Computation ability does have a significant effect on problem-solving ability. With the effects of I. Q. controlled, above grade level scores on the reasoning test appear to bear a closer relationship to computation ability than to reading ability.

4. The lack of a significant interaction suggests that for a given level of computation ability, problem-solving increases as reading increases, and that for any given level of reading ability, problem-solving increases as computation ability increases.

5. The findings of this study point out the importance of considering children's reading ability as well as computation ability when teaching problem-solving skills. Both of these factors are important to the child if he is to deal adequately with verbal problems in his school work.

For a number of years one primary objective of arithmetic instruction has been to teach pupils to solve arithmetic "story" problems. Yet problem-solving continues to present some of the most persistent difficulties in arithmetic instruction. A considerable amount of opinion and objective data indicate that pupils do not achieve as well in arithmetic problem-solving as they do in arithmetic computation.

Thirty years ago Newcomb reported that it was "common knowledge" of every teacher of arithmetic that the most difficult part of the subject is the securing of satisfactory results in the solution of the problems.[1]

In an article published in 1956 Spitzer and Flournoy expressed the opinion that, "The important objective of achievement in verbal problem-solving isn't often reached satisfactorily and students of arithmetic teaching are well aware of this."[2] Most elementary-school

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[1]R. S. Newcomb, "Teaching Pupils How to Solve Problems in Arithmetic," Elementary School Journal, XXIII (November, 1922), p. 183.

[2]Herbert F. Spitzer and Frances Flournoy, "Developing Facility in Solving Verbal Problems," Arithmetic Teacher, III (November, 1956), p. 177.

teachers today find that verbal problems cause difficulty. Faced with the task of solving the children often become frustrated and confused.

Students of arithmetic teaching need to make studies to determine whether proposed problem-solving improvement procedures found in children's textbooks actually contribute to a student's ability.

Monroe and Engelhart report a study by Stevenson in 1924 which stressed certain aspects of problem-solving similar to those of this study. For a period of twelve weeks, Stevenson used 1,027 fifth, sixth, and seventh grade pupils who were taught to read and analyze problems and to estimate answers in round numbers. Part of the twelve weeks was used to have pupils state the problems in their own words, to solve problems without the use of numbers, to work a variety of problems dealing with real-life situations, and to estimate answers in round numbers.[1]

About Stevenson's study Monroe and Engelhart say, "The gains in achievement are certainly significant . . . It is unfortunate that control groups were not used."[2]

Summary of related literature.--The literature reviewed has been concerned with arithmetic underachievers, the relationship between reading and arithmetic, and the relationship of quantitative reasoning to reading.

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[1]Walter S. Monroe and Max D. Englehart, A Critical Summary of Research Relating to the Teaching of Arithmetic, University of Illinois, Bureau of Educational Research, Bulletin 58 (Urbana: University of Illinois, 1931), p. 115.

[2]Ibid.

The literature reviewed concerning arithmetic underachievers indicated that subjects used in an investigation were able to reason word problems involving addition and subtraction of whole numbers, but made frequent reasoning errors in problems involving multiplication and division of whole numbers as well as in all the processes involving common fractions. Sixteen out of twenty subjects were one or more years below their mental grade level as measured by the Durrell Analysis of Reading Difficulty.

Some authorities believe that there is a positive relationship between scores made in paragraph meaning and arithmetic reasoning. It was found that good readers were the best problem solvers.

Reading is important for understanding and for wholesome adjustment. Research indicates that the reading of verbal problems calls for some special reading skills. It has been pointed out that pupils inability to comprehend the statement of the problem and lack of vocabulary are among the most significant reasons why pupils have difficulty in solving problems. Many agree that understanding the terms used in arithmetic is a definite factor in problem-solving efficiency and the study of mathematical vocabulary should be an important objective of instruction.

One authority has stated that more detailed research should be undertaken to show how much time and effort should be expended in giving pupils a method of attacking problems, in training them to estimate answers, and in assisting them to understand technical words and other phases of instruction.

In several investigations authorities conclude that general reading ability does not have an effect on problem-solving when a total range of reading ability was used rather than two groups defined as good and poor readers and when the effect of intelligence was controlled. When I. Q. is not controlled, much of the apparent relationship between reading and problem-solving ability is the result of the high correlation of each of these factors with I. Q. Controlling I. Q. drastically reduces the degree of relationship.

CHAPTER II

PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA

Introduction

This chapter presents, analyzes and interprets data collected for the purpose of achieving the major aim of this study. It is devoted primarily to the presentation of data designed to ascertain whether or not pupils can be differentiated, in terms of ability to reason quantitatively, by level of competence in performance of a selected group of reading skills. The null hypotheses to be tested were:

> Subjects who are high achievers in solving arithmetic reasoning problems are not significantly more competent in word attack skills than are subjects who are low achievers in the solving of arithmetic reasoning problems.
>
> Subjects who are high achievers in solving arithmetic reasoning problems do not score significantly better on selected vocabulary tests than do subjects who are low achievers in the solving of arithmetic reasoning problems.
>
> Subjects who are high achievers in solving arithmetic reasoning problems do not test significantly higher on the reading comprehension component of an achievement battery than do subjects who are low achievers in the solving of arithmetic reasoning problems.

Information on Selection and Classification of Subjects

The subjects for this study were randomly selected from the fourth grade pupils. The California Short-Form Test of Mental Maturity,

Elementary, 1963 S Form was administered and the I. Q.'s ranging from 80-110 were used as the measure of intelligence. Once a random selection had been made of fifty children meeting the above criteria, selections were made on the basis of performances in arithmetic reasoning components of the Metropolitan Achievement Test, Elementary Battery, Form A, 1959. Pupils whose scores comprised the highest third for the entire group were grouped as high arithmetic achievers, while pupils whose scores comprise the lowest third for the entire group were grouped as low arithmetic achievers.

They were classified according to their reading ability on the basis of performance in vocabulary and comprehension components of the Metropolitan Achievement Test, Elementary Battery, Form A, 1959. Further classification were determined, according to their reading ability on the basis of performances in word attack skills on each component of the McCullough Word Analysis Test, Experimental Edition.

The mean and standard deviation were computed for high and for low achievers in arithmetic problems-solving. Fisher's t was used to test for significance of differences between the means. The decision to accept or reject a null hypothesis depends upon the level of significance adopted. The level of significance adopted for this study was .01. Fisher's t, for testing significant differences, with a population of 32, required 2.750 or greater for rejection at the .01 level and smaller than 2.750 for acceptance at the .01 level.

Table 1 presents the raw scores of the high achievers and low achievers on word attack skills, vocabulary and comprehension.

TABLE 1

RAW SCORES OF THE HIGH ACHIEVERS AND LOW ACHIEVERS

Word Attack Scores		Vocabulary Scores		Comprehension Scores	
High Achievers	Low Achievers	High Achievers	Low Achievers	High Achievers	Low Achievers
116	112	26	18	27	15
114	106	23	17	25	15
110	102	22	15	24	15
108	98	19	14	22	15
108	94	19	13	21	13
106	90	16	13	20	11
105	83	15	13	18	11
102	81	14	13	15	11
102	75	13	12	14	11
102	74	13	10	13	11
100	74	12	10	12	10
96	73	12	8	12	8
92	61	9	8	11	6
91	54	8	7	10	6
81	51	7	6	10	6
77	49	2	4	9	4
M = 101	M = 80	M = 14	M = 11	M = 16	M = 11
S.D. = 10.6	S.D. = 10.03	S.D. = 6.164	S.D. = 3.848	S.D. = 5.80	S.D. = 3.55
t = 3.732		t = 1.590		t = 2.845	

Sixteen high achievers and sixteen low achievers word attack scores are presented in Table 1. Scores range for high achievers from a low of 77 to a high of 116, with a mean of 101, and a standard deviation of 10.6. Scores for low achievers range from a low of 49 to a high of 112, with a mean of 80 and a standard deviation of 19.03.

The difference between the means of 101 and 80 was tested for significance using Fisher's t. The obtained t of 3.732 was found to be significant at the .01 level of confidence. Therefore the hypothesis must be rejected since the data indicates the high achievers in solving arithmetic problems are significantly more competent in word attack skills than are the low achievers in solving arithmetic problems.

Table 1 presents vocabulary scores for the sixteen high achievers and the sixteen low achievers. Scores of high achievers range from a low of 2 to a high of 26, with a mean of 14, and a standard deviation of 6.6164. Scores of low achievers range from a low of 4 to a high of 18, with a mean of 11 and a standard deviation of 3.848.

The difference between the means of 14 and 11 was tested for significance using Fisher's t. The obtained t of 1.590 is not significant at the .01 level. This requires acceptance of the hypothesis that subjects who are high achievers in solving arithmetic reasoning problems do not score significantly better on selected vocabulary tests than do subjects who are low achievers in solving arithemtic reasoning problems.

Data obtained from the comprehension scores made by sixteen high achievers and sixteen low achievers are presented in Table 1. Scores range, for high achievers, from a low of 9 to a high of 27, with a mean

of 16, and a standard deviation of 5.80. Scores for low achievers range from a low of 4 to a high of 15, with a mean of 11, and a standard deviation of 3.55.

The difference between the means of 16 and 11 tested for significance using Fisher's t. The obtained t of 2.845 was found to be significant at the .01 level of confidence. The hypothesis must be rejected since the results indicate that high achievers in solving arithmetic reasoning problems do score significantly higher on the reading comprehension component of an achievement test battery than do subjects who are low achievers in the solving of arithmetic reasoning problems.

Summary of Findings

The analysis of the two groups of subjects under study has yielded information concerning whether or not high and low achievers can be differentiated in terms of ability to reason quantitatively in solving arithmetic reasoning problems by the level of competence in performance of a selected group of specific reading skills.

A close inspection of the high achievers and low achievers differential abilities revealed that the subjects who were in arithmetic reasoning problems were more competent in word attack skills than subjects who were low achievers in the solving of arithmetic reasoning problems.

The subjects who were high achievers in arithmetic reasoning problems were not more competent in vocabulary than subjects who were low achievers in the solving of arithmetic reasoning problems.

The subjects who were high achievers in arithmetic reasoning problems were more competent in comprehension than subjects who were low achievers in the solving of arithmetic reasoning problems

CHAPTER III

SUMMARY OF CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Rationale

Reading is generally considered the most essential subject that is taught in the elementary schools of today. The ability to use reading skills effectively is the tool through which the child obtains a large portion of the subject matter of the content fields. It is important that the child acquires a certain facility in reading and be able to transfer the skills learned in reading to the tasks which must be mastered in each content area.

In the modern curriculum pupils read more widely than ever before to develop reading competence for more specialized types of reading.

The changing philosophy of education, increased knowledge of child development, clarification of the nature of human learning, a rethinking of the purposes of instruction in arithmetic, and, changes in our culture influenced the arithmetic curriculum in being more realistic about what children need in arithmetic.

The development of the total individual is a fundamental objective of the modern elementary school. Realizing this objective necessitates a kind of learning situation which will foster total growth

of the child mentally, physically, socially, emotionally and morally.

Reading may be considered somewhat essential to the development of quantitative reasoning skills, or as has been discussed, to some aspects of the application of reading skills to arithmetic problem solving.

Recapitulation of Problems and Purposes

The problems with which this study concerns itself is that of identifying specific reading skills which are related to high and low achievement in arithmetic problem solving.

It was the general purpose of this study to ascertain whether or not pupils can be differentiated in terms of ability to reason quantitatively by competence in performance of a selected group of reading skills. The study therefore tests the following null hypotheses: high achievers in solving arithmetic reasoning problems are not significantly more competent in word attack skills than low achievers in solving of arithmetic reasoning problems; high achievers in solving arithmetic reasoning problems do not score significantly better on selected vocabulary tests than low achievers in the solving of arithmetic reasoning problems; high achievers in solving arithmetic reasoning problems do not test significantly higher on the reading comprehension components of an achievement battery than low achievers in the solving of arithmetic reasoning problems. Specifically the differences in performances on word attack skills measured by the McCullough Word Analysis Test, on the vocabulary component and on the reading comprehension component of the Metropolitan Achievement Test were compared for low and

high achievers in arithmetic reasoning. Finally, the study attempted to draw implications which may lead to better instructional purposes and to formulate conclusions and recommendations as warranted by the findings of the study.

Research Procedure

The Descriptive Survey Method of research was used in this investigation.

The subjects for this study were randomly selected from fourth grade pupils whose I. Q.'s range from 80 - 110 and whose chronological ages range nine years to ten years, eleven months.

Once a random selection had been made of fifty children meeting the above criteria, selections were made on the basis of performances in arithmetic reasoning components of the Metropolitan Achievement Test as recorded in permanent record folders. Pupils whose scores comprise the highest third for the entire group were identified as high achievers, while pupils whose scores comprise the lowest third for the entire group were identified as low arithmetic problem solving achievers.

The instruments used in this study were: The California Short-Form Test of Mental Maturity, The Metropolitan Achievement Tests and the McCullough Word Analysis Tests.

The data were organized from the results of these tests. Following the organization of data pertaining to subjects performances, data were organized in terms of inhibiting factors experienced by the subjects for each group. In the analyzing process, the data were reported and interpreted statistically in terms of the mean, standard deviation and Fisher's t.

Summary of Related Literature

The literature pertinent to this study is summarized in the statements below:

1. There is a positive relationship between scores made in paragraph meaning and arithmetic reasoning. Good readers were the best problem solvers.

2. Research indicates that the reading of verbal problems calls for some specific reading skills.

3. Pupils with inability to comprehend the statement of the problem and pupils lack of vocabulary have difficulty in solving problems.

4. Understanding the terms used in arithmetic is a definite factor in problem-solving efficiency.

5. The study of mathematical vocabulary should be an important objective of instruction.

Summary and Interpretation of Findings

To measure differential abilities in arithmetic problems solving among sixteen high achievers and sixteen low achievers of average intellectual ability, several test and screening devices were used. The following results appeared during the course of investigation.

1. The difference between the means of 108 and 80 was tested for significance in word attack skills using Fisher's t. The obtained t of 3.732 was found to be significant at the .01 level of confidence. This indicated the high achievers in solving arithmetic problems were more significantly competent in word attack skills than low achievers in solving arithmetic problems.

2. The difference between the means of 14 and 11 was tested for significance in vocabulary using Fisher's t. The obtained t of 1.590 is not significant at the .01 level. This indicated the high achievers in solving arithmetic problem solving were not more competent in vocabulary than low achievers in solving arithmetic problems.

3. The difference between the means of 16 and 11 was tested for significance in comprehension using Fisher's t. The obtained t to 2.845 was found to be significant at the .01 level of confidence. This indicated the high achievers in arithmetic problem solving were more competent in comprehension than low achievers in arithmetic problem solving.

Conclusions

An analysis of the basic findings of this study warranted the formulation of the following conclusions:

1. With intelligence held constant, those subjects with good work attacks skills do better in arithmetic problem solving than subjects who have poor or low word attack skills.

2. With intelligence held constant, those subjects with a high score on vocabulary do not seem to do any better in arithmetic problem solving than those subjects with a low score in vocabulary problem solving.

3. With intelligence held constant, those subjects with a high degree of reading comprehension do better in arithmetic problem solving than subjects who have a low degree of reading comprehension.

Implications

An analysis of the basic findings of this study warranted the following implications:

1. Once a learner has begun to experience difficulty with reading skills, unless some specific instructional program is planned for the learner, the difficulties may become severe as he grows older.

2. There is need for more effective systematic training in specific reading skills used as word attack skills and comprehension techniques in the elementary schools.

3. If the level of reading ability in word attack skills and comprehension can be improved, subjects will do better arithmetic problem solving.

Recommendations

The following recommendations are hereby made:

1. A general diagnosis should be made at the beginning of the school year in order to ascertain the general strengths and weaknesses of the pupils and to screen out those who are in need of a more analytical diagnosis of their poor reading skills and thus, provide information necessary in planning a specific instructional program to meet their needs.

2. Pupils should be given more assistance in understanding technical words.

3. Instructional materials should be chosen in harmony with goals of instruction and the reading levels, and interest of the students.

4. The study of mathematical vocabulary should be an important objective of instruction.

BIBLIOGRAPHY

Books

Bruckner, Leo J. and Grossnickle, Foster E. Making Arithmetic Meaningful. Philadelphia: The J. C. Winston Company, 1953.

Caswell, Hollis L. and Forshay, Wellesley A. Education in the Elementary Schools, second edition. New York: American Book Company, 1950.

Harris, Albert J. How to Increase Reading Ability. New York: David MacKay Company, 1961.

Merry and Merry, R. The First Two Decades of Life. New York: Harper & Brothers Publishers, 1958.

Monroe, Marion. Children Who Cannot Read. Chicago: University of Chicago Press, 1932.

Johnson, Palmer O. and Jackson, Robert W. B. Modern Statistical Methods. Chicago: Rand McNally & Company, 1959.

Smith, Nila Banton. Reading Instruction for Today's Children. Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1963.

Spache, George D. Toward Better Reading. Champaign, Illinois: Garrard Publishing Company, 1963.

Wilson, Guy. "Arithmetic." Encyclopedia of Educational Research. New York: The Macmillan Company, 1950.

Periodicals

Coffing, Esther A. "The Relationship Between Silent Reading Ability and Arithmetic Ability," School Science and Mathematics, XLI (January, 1949), pp. 10-14.

Corle, Clyde S. "Thought Processes in Grade Six Problems," The Arithmetic Teacher, V (October, 1958), pp. 193-203.

Eagle, Edwin. "The Relationship of Certain Reading Abilities to Success in Mathematics," The Mathematics Teacher, XLI (April, 1948), pp. 175-179.

Fay, Leo F. "The Relationship Between Specific Reading Skills and Selected Areas of Sixth-Grade Achievement," Journal of Educational Research, XLII (March, 1950), pp. 544-47.

Hagaman, Adaline P. "World Problems in Elementary Mathematics," The Arithmetic Teacher, XI (January, 1964), p. 250.

Hansen, Carl. "Factors Associated with Successful Achievement in Problem Solving in Sixth Grade Arithmetic," Journal of Educational Research, XXXVIII (October, 1944), p. 115.

Johnson, J. T. "On The Nature of Problem Solving in Arithmetic," Journal of Educational Research, XLIII (October, 1949), pp. 110-115.

Junge, Charlotte. "The Arithmetic Curriculum," The Arithmetic Teacher, I (April, 1964), p. 154.

Monroe, Walter S. "The Derivation of Reasoning Tests in Arithmetic," School and Society, VIII (September, 1918), 295-99, 324-29.

Monroe, Walter S. and Engelhart, Max D. A Critical Summary of Research Relating to the Teaching of Arithmetic. University of Illinois, Bureau of Educational Research, Bulletin 58. Urbana: University of Illinois, 1931, p. 115.

Newcomb, R. S. "Teaching Pupils How To Solve Problems in Arithmetic," Elementary School Journal, XIII (November, 1922), p. 183.

Ross, Ramon. "A Description of Twenty Arithmetic Underachievers," The Arithmetic Teacher, XI (April, 1964), pp. 235-241.

Russell, David H. "Arithmetic Power Through Reading," Instruction in Arithmetic, Twenty-fifth Yearbook, Chapter 9. Washington: National Council of Teachers of Mathematics, 1960, pp. 211-12.

Spitzer, Herbert F. and Flournoy, Frances. "Developing Facility in Solving Verbal Problems," Arithmetic Teacher, II (November, 1956), p. 177.

Stevenson, P. R. "Increasing the Ability to Solve Arithmetic Problems," Educational Research Bulletin, III (October, 1924), pp. 267-270.

Strang, Ruth. "Relationships Between Certain Aspects of Intelligence and Certain Aspects of Reading," Educational and Psychological Measurement, III (May, 1943), pp. 355-59.

Treacy, John P. "The Relationship of Reading Skills to the Ability to Solve Arithmetic Problems," Journal of Educational Research, XXXV (October, 1944), pp. 174-179.

Unpublished Materials

Hansen, C. W. "Factors Associated With Superior and Inferior Achievement in Problem Solving in Sixth-Grade Achievement." Unpublished Ph.D. dissertation, University of Minnesota, 1943.

Fuse, B. L. "The Relationship of Solving Arithmetic Reasoning Problems To certain Other Aspects of Learning." Unpublished Master's thesis, Department of Education, Atlanta University, Atlanta, Georgia, 1954.

Hogg, Johnny C. "A Comparative Study of the Relationship Between Retrospective Levels of Comprehension and Arithmetic Verbal Problem-Solving of Fifth, Ninth, and Tenth Grade Pupils in La Grange, Georgia." Unpublished Master's thesis, Department of Education, Atlanta University, Atlanta, Georgia, 1953.

Test Manuals

Durost, W. N. Metropolitan Achievement Tests. (Elementary Battery), Form A. New York: Harcourt, Brace and World, Inc., 1959.

McCullough, Constance M. McCullough Word-Analysis Tests. Atlanta: Ginn and Company, 1963.

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